

Typicality Effects and the Logic of Reciprocity

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Synopsis This paper extends the *Strongest Meaning Hypothesis* on reciprocals [1] into a more powerful hypothesis, and reports experimental results supporting the proposed generalization. We argue that the logical semantics of reciprocals are directly derived by the relational concept within their scope. Considering *typicality effects* with verbs, we extend the SMH into a more general *Maximal Typicality Hypothesis* (MTH), which respects meanings of verbs like *know*, *pinch* or *hug* better than [1]’s assumptions. We report on experiments testing typicality with relational concepts, and their correlation with the interpretation of reciprocal sentences that refer to these concepts. The observed correlations are unexpected by the SMH but systematically support the MTH.

Background Reciprocal Meanings like *each other* depend on the meaning of the relation they combine with. In *Bob, Joe and Bill know each other*, each of the men is required to know the other two – a *complete graph* situation. By contrast, in *Bob, Joe and Bill are standing on each other*, Bob may be standing on Joe, who is standing on Bill. This illustrates a *path graph* situation. Following [1], many works have accounted for such differences using the SMH, which in one of its formulations [3] is stated as follows: *A reciprocal sentence is consistent with models in which no pair can be added to the reciprocated n -ary relation without violating restrictions of the corresponding n -ary relational concept.* This accounts for the weakened interpretation of the reciprocal with the verb *stand (on)* compared to *know*. In a path graph situation, adding any pair to the relation would contradict the acyclicity of *stand on*, hence such situations are supported in *stand on each other*. By contrast, no lexical property of the verb *know* prevents a complete graph situation, hence this is the preferred situation for *know each other*.

Problem The SMH is far from covering the facts about “weakened” reciprocity. In many cases the reciprocal’s interpretation is weaker than what the SMH expects:

- (1) Mary, Sue and Jane are pinching/stabbing/scraping/hitting each other.

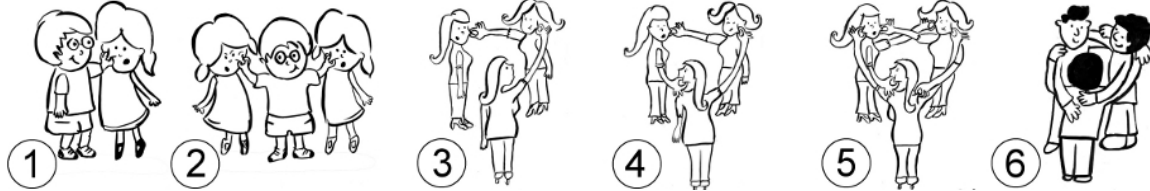
Common intuitions, corroborated by pilot experiments (not reported here), accept sentences like (1) in *circle graph* situations, where each of the women is pinching (stabbing etc.) another woman in a circular configuration (cf. fig. 4). However, common world knowledge accepts a complete graph (e.g. fig. 5) as perfectly possible in (1). Thus, the SMH expects only a complete graph to support sentence (1), contrary to fact.

Proposal We propose that the SMH fails in such cases because it does not respect the full meaning of relational concepts. We show experimentally that just like individual bird instances (e.g. a robin vs. a chicken) can have different typicality [2] as instances of the unary concept BIRD, so can different denotations of a binary relational concept be more or less typical of the concept. E.g. a relation in which a person only pinches one other person is more typical of the concept PINCH than a relation in which a person pinches two people simultaneously. We assume that the reciprocal is sensitive to the typicality of the relation with which it composes – instead of the maximal logical strength assumption of the SMH, we propose that reciprocals require a relation with *maximal typicality*.

- (2) **Maximal Typicality Hypothesis** (MTH): A reciprocal expression is consistent with models in which no pair can be added to the reciprocated n -ary relation without reducing its typicality relative to the relational concept.

In (1), adding a pair to a circle graph would result in a relation in which one woman

is pinching two other women, presumably reducing the typicality of the relation as an instance of the PINCH concept. Thus, the MTH correctly expects the circle graph to be accepted by the reciprocal. We show that the MTH generalizes the SMH in a strictly formal sense: the MTH replaces the SMH’s discrete restrictions on relational denotations (e.g. acyclicity of *stand on*) by graded scores, which are assigned to the denotations by the *typicality function* of the relational concept [2].



Experiments We conducted two sets of experiments on 50 university students that are native Hebrew speakers. To examine *typicality* of each verb, i.e. preference for a single/multiple patient(s), in experiment 1^T the participants were asked of figures like 1 and 2, which one better illustrates an intransitive sentence with the relational concept (here - *the boy is pinching*). To test influences of typicality on reciprocals, experiment 1^R similarly presented a choice between figures like 4 and 5 (or 3 and 4) as illustrating a reciprocal sentence (here - *the girls are pinching each other*). Experiment 2^T presented a choice between a singular/plural object (e.g. “*Sue saw Ron stabbing the girl/girls*”). Correlation was then checked with experiment 2^R , which tested the validity of entailments illustrating complete-graph situations (e.g. $(1) \Rightarrow \textit{Sue is stabbing Mary}$).

1: %-preference/verb	xibek hug	cava' paint	sarat scrape	cavat pinch	serek comb	nigev wipe	hika hit	dakar stab
1^T - single patient preferred	32	69	72	75	77	81	87	88
1^{R-i} - circle preferred over complete	10	24	40	30	65	40	18	38
1^{R-ii} - path preferred over circle	2	0	6	2	6	6	4	6
2: %-preference/verb	ra'a see	hikSiv le listen to	hichi'a 'al point at	hexmi le compliment	dakar stab	sarat scrape		
2^T - single patient preferred	63	67	73	77	86	96		
2^R - complete graph not entailed	4	8	12	14	31	29		

Conclusions The results of experiment 1^R show that unlike the predictions of the SMH, verbs often show significant preference (30% or more) for circles, even when a complete graph is visibly possible. Both experiment sets show correlation between single patient preference and preference of a circle to a complete graph. Thus, in experiment 1^T , for the verb *xibek* (“hug”) participants preferred 2 patients over 1 patient per agent much more than for the other verbs (68% vs. 31% or less). Accordingly, in experiment 1^{R-i} , for *xibek*, participants preferred a complete graph (fig. 6) for the reciprocal sentence more than for the other verbs (90% vs. 76% or less). This is notable, since with all verbs in experiment 1^{R-ii} , circles were strongly preferred to paths. Thus, the percentage of preferring circles to complete graphs with the other verbs besides *xibek* is significant, although it is below 50% for most verbs. A similar correlation between typicality and reciprocity is observed in experiment set 2: the more preferable singular objects of a verb are in the sentence completion test, the less acceptable is the entailment from the reciprocal sentence to a complete graph (“strong reciprocity”). Thus, typicality judgements systematically affect the logical interpretation of reciprocal sentences in the way expected by the MTH.

References [1] Dalrymple et al. 1998: “Reciprocal expressions and the concept of reciprocity”, *L&P* 21. [2] Osherson & Smith 1997: “On typicality and vagueness”, *Cognition* 64. [3] Sabato & Winter 2005: “From semantic restrictions to reciprocal meanings”, *proc. of FG-MOL*.